PA JT COOPERATION TREAT`

From the INTERNATIONAL BUREAU

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 21 February 2001 (21.02.01)	
International application No. PCT/IL00/00347	**Applicant's or agent's file reference** 1151
International filing date (day/month/year) 13 June 2000 (13.06.00)	**Priority date** (day/month/year) 14 June 1999 (14.06.99)
Applicant FIGOV, Murray	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

10 January 2001 (10.01.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

R. E. Stoffel

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference ...	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IL00/00347	International filing date *(day/month/year)* 13/06/2000	Priority date *(day/month/year)* 14/06/1999
International Patent Classification (IPC) or national classification and IPC G03F7/12		
Applicant CREOSCITEX CORPORATION LTD.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of twenty-one sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10/01/2001	20.08.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Korb, W Telephone No. +49 89 2399 2284

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL00/00347

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1,2,7,8	as originally filed			
3,3a-3b,4-6, 9-18	as received on	06/08/2001	with letter of	02/08/2001

Claims, No.:

24-26	as originally filed			
1-23	as received on	06/08/2001	with letter of	02/08/2001

Drawings, sheets:

1/7-7/7	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 - 23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1 - 23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1 - 23
	No:	Claims	

2. Citations and explanations
   see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. There is no doubt in regard of the possibility of an industrial applicability of the subject-matter claimed in claims 1 - 23.

   Furthermore the subject-matter of independent claims 1 and 10 is considered to be new and to involve an inventive step with respect to the available documents cited in the International Search Report and representing a state of the art according to Rule 64(1) PCT.

   The dependent claims 2 - 9 and 11 - 23 refer to claim 1 or claim 10 directly or indirectly and meet the requirements for such claims with regard to novelty and inventive step.

2. The present application provides a method for producing a screen using digital imaging, and an image-ready screen printing blank usable in a screen printing process which is comprised of a screen coated with a photosensitive coating that permits aqueous-based inkjet ink to be deposited evenly on its surface and remain in liquid condition.

   The problems to be solved are providing optimum ink-screen surface interaction to produce a high quality inkjet mask, together with very easy removal of the mask after it has fulfilled its masking function and providing screen formulations that make this possible.

   The documents available from the ISR present integral inkjet masks in which inkjet has been used to produce masks on the screen itself so that the unimaged, unprotected parts of the coated screen can be flood cured by UV radiation. They do not, however, present workable solutions to the problem of ink receptivity and washability of the ink after curing.

   Only two of the available documents recognize the problem of post flood-curing washout and try to deal with it. PCT WO 98/51750 (Markem Corporation)

describes such a process. The inks used are "phase change" - known also as hot-melt inks. The ink is heated before application and dries by solidification as it impacts the screen. The PCT WO 98/51750 recognizes the difficulty of removing the solid ink after it had served its purpose as a mask and the inks are formulated to be auto-dispersible in water.

Furthermore GB 2 315 076 (Sericol) recognizes the same problem when phase change inks are used as integral masks for screen printing. Their solution is to use a water-soluble material having a wax-like texture.

The fact that the inks cited in the prior art are solid necessitates either the penetration of the ink film by the washing solution or the salvation or autodispersion of successive top surfaces of the ink to accomplish complete ink removal.

US 5,878,076 (McCue) attempts to circumvent the problem of mask removal after UV flood-exposure by depositing only the screen itself by, for instance, inkjet, so that the deposit is in all areas except those of the image. The deposit is then subsequently flood-cured by UV from both sides. As a layer of inkjet ink is relatively thin, multiple passes may be required to achieve the desired screen thickness.

In contrast, the present application provides an integral inkjet ink mask which remains liquid on a properly receptive photosensitive coating to provide ease of washing.

None of the available documents, neither standing alone or in combination can render the solution according to the present application obvious, that is an aqueous-based ink for deposition on a properly receptive mask to allow the ink to remain liquid and to be easily washed away with the uncured areas of the photosensitive coating.

There are other, indirect methods of producing the stencil. The light sensitive coating may be prepared as a pre-sensitized film on an intermediate base. The film can then either be transferred onto the screen before exposure and development or after exposure and development.

There is a growing need in many markets to print low run lengths and print on demand. This is because it is expensive to carry large stocks of pre-printed items and because there is an increasing demand for product customization to the need of individual customers or to relatively small groups of customers instead of mass production. The speed and cost of screen production becomes important and any means of simplifying and reducing costs is advantageous. There is also a trend to use computers to prepare artwork for printing and it would obviously be more convenient if the screen could be prepared directly from the computer information without recourse to the preparation of an intermediate photomask.

Inventors have attempted to use inkjet to produce masks on the screen itself, so that the unimaged, unprotected parts of the screen can be flood-cured by UV radiation. An example of this is described in EP 0 492 351 B1 by Gerber Scientific Products Inc. The problems of ink receptivity of the screen are acknowledged and the preferred method of overcoming these problems is by the introduction of talc onto the surface of the screen, to absorb the ink-jetted ink. This absorbs the liquid medium of the ink, to give a dried graphic. The graphic is described as preferably formed from a water-soluble ink.

Subsequently, similar inkjet integral masks have also been used to produce flexo plates. WO 97/25206 (Polyfibron) describes such a method. The inks used are either

solvent based or "phase change". After deposition, the ink is dried by evaporation of the volatile solvent or, in the case of phase change inks, by solidification. After the ink mask is used by flood-exposing the plate with UV light, the image areas are washed out. No mention is made of any difficulties in removing the dry mask after flood-exposure, save to point out that inks are useful so long as they can be removed by subsequent washing, without damaging the surface of the plate.

The following later patents recognize the problem of post flood-curing washout and try to deal with it. PCT WO 98/51750 (Markem Corporation) describes such a process. The inks used are "phase change" – known also as hot-melt inks. The ink dries by solidification as it impacts the screen. The patent recognizes the difficulty of removing the solid ink after it had served its purpose as a mask and the inks are formulated to be auto-dispersible in water.

GB 2 315 076 (Sericol) recognizes the same problem when phase change inks are used as integral masks for screen printing. Their solution is to use a water-soluble material having a wax-like texture.

US 5,878,076 (McCue) attempts to circumvent the problem of mask removal after UV flood-exposure by depositing only the screen itself by, for instance, inkjet, so that the deposit is in all areas except those of the image. The deposit is then subsequently flood UV-cured from both sides. As a layer of inkjet ink is relatively thin, the patent provides the possibility of multiple passes to achieve the desired screen thickness.

Therefore, it would be desirable to provide a method for screen printing which would not require the production of an intermediate positive film, would allow screen masters to

be imaged directly from digital information in the computer so as to simplify the known work flow of the printing process, would provide an easily washable ink for forming the mask and would be quicker and more economical to use.

SUMMARY OF THE INVENTION

Accordingly, it is a broad object of the present invention to overcome the problems of the prior art and provide a method of producing a digital screen directly from digital information in the computer in an economical fashion. Specifically, the invention seeks to overcome the problems of providing optimum ink-screen surface interaction to produce a high quality inkjet mask, together with very easy removal of the mask after it has fulfilled its masking function and to provide screen formulations that make this possible.

In accordance with a preferred embodiment of the present invention, there is provided a method of producing a screen using digital imaging, said method comprising the steps of:

providing digital image information from a computer system;

providing an image-ready printing blank comprised of a screen coated with a photosensitive coating that permits aqueous-based inkjet ink to be deposited evenly on its surface and remain in liquid condition;

printing said digital image information in UV-blocking aqueous-based inkjet ink on said photosensitive coating with an ink-jet printer, forming an image structure having exposed and unexposed areas of said photosensitive coating;

flood-curing said photosensitive coating having said formed image structure with UV light such that said exposed areas of said photosensitive coating are cured while said unexposed areas of said photosensitive coating are blocked from UV curing by said UV-blocking ink; and

washing said photosensitive coating so that said UV-blocking ink and said unexposed image structure areas are removed,

such that the remaining cured areas of said photosensitive coating form a mask on said screen for use in the screen printing process.

In accordance with another aspect of the invention there is provided a screen printing blank usable in a screen printing process, said printing blank comprising:

an image-ready printing blank comprised of a screen coated with a photosensitive coating that permits aqueous-based inkjet ink to be deposited evenly on its surface and remain in liquid condition.

In a preferred embodiment, a screen is provided with a photosensitive coating, and a digitally determined image from a computer is printed on the screen by means of an inkjet printer. It is preferable to use a flat bed ink-jet imaging system so that the screen can be stretched in a frame and directly placed under the ink-jet head. The ink used need not have strong colorant, but functions as a UV mask and thus must contain a UV absorbing pigment. The ink is not absorbed into the photosensitive coating, but remains as an undried image on the surface. The ink must remain wet so that that it does not spread and therefore gives a sharp image, and so that the UV absorbent material remains concentrated The screen is then irradiated with UV, and the areas which have been printed with ink serve to mask the photosensitive coating from the UV light, while those areas having no ink are exposed so that the photosensitive coating is polymerised by the UV.

After the UV irradiation stage, the screen is washed so as to remove the ink and the unpolymerised photosensitive coating. Any liquid that is suitable for washing out the unpolymerised photosensitive coating will also wash away the ink. This leaves the screen with only the polymerised areas of the photosensitive coating that create the blocked areas through which the ink will not pass.

Thus, the inventive method provides a digitally imaged screen, directly from a digital image in the computer, which can then be used in any conventional screen printing process.

Other features and advantages of the invention will become apparent from the following drawings and descriptions.

Positive film 32 is comprised of black, UV-opaque image areas and clear, UV-transparent background, or non-image areas, and functions as a UV mask in contact with stencil 20.

Figure 2b shows the exposure of the combination of film image 32 and stencil 20 to flood UV light. Coatings 30 are selectively hardened into a printing pattern by exposure to UV light through positive film 32 in which the image areas are opaque to the UV light. UV light penetrates film image 32 in the non-image areas and cures the corresponding areas of photosensitive coating 30 creating cured, cross-linked polymeric material 34.

Film image 32 is then physically removed and screen 28 is washed with a solvent, which may be water. As seen in Fig. 2c, the washing removes the uncured areas of photosensitive coating 30 leaving only the open woven mesh of screen 28 in these areas, while retaining cross-linked polymeric material 34. Stencil 20 may then be used for printing as described in Fig. 1.

There are other, indirect methods of producing the stencil. The light sensitive coating may be prepared as a pre-sensitized film on an intermediate base. The film can then either be transferred onto the screen before exposure and development or after exposure and development.

Prior art Figures 3a-e show cross-sectional views of an indirect method of transfer from an intermediate material to the screen after the imaging and washing stages. Figure 3a shows the donor sheet, characteristically a UV transparent substrate 36, comprised of a material such as polyester, coated with a photosensitive coating 38. A positive film serves as photomask 40 and is laid in contact with coating 38. Figure 3b depicts a UV

exposure through photomask 40 onto coating 38. Where the UV is not blocked by photomask 40, coating 38 is hardened by polymerisation. The areas of coating 38 which were directly under the UV opaque areas of photomask 40 remain unaffected. Photomask 40 is then physically removed and the surface of coating 38 is washed, usually with either an organic solvent or a weak alkali solution. This solution washes out the unpolymerised areas, leaving the polymerised areas of coating 38 as depicted in Figure 3c. Coating 38 is then pressed in contact with screen 28 as shown in Figure 3d and either by means of pressure, heat or solvent, is transferred to the screen as shown in Figure 3e, thus providing areas in which the ink is blocked, for the screen printing process.

Prior art Figures 4a-d describe an indirect transfer process where transfer from an intermediate material to the screen is done before the imaging and washing stages. Figure 4a shows support 42 coated with photosensitive coating 38 being pressed together with the screen 28, so as to transfer the photosensitive material to screen 28. As in Fig. 3, the transfer may be affected either by heat or pressure or a combination of these, or by solvent, possibly combined with heat and pressure. Support 42 is then physically peeled away and the resulting screen is shown in Fig. 4b. UV flood exposure through photomask 40 is shown in Fig. 4c. This cures the areas which are not blocked by photomask 40. After subsequent washing, as previously described, a print-ready screen results, as shown in Fig. 4d.

Fig. 5 shows a photosensitive screen stencil which has been imaged and washed according to one of the above described procedures. The image areas show the exposed screen through which ink may pass during printing.

Referring now to Figs. 6a-d, which describe the present invention. Fig. 6a shows screen 28 with a photosensitive coating 38 coated within the screen.

Fig. 6b shows an ink jet head 44 jetting aqueous inkjet ink 46 onto the surface of photosensitive coating 38 of screen 28. The system shown is, by way of example, a generic impulse (drop-on-demand) system, although any type of ink jet system is usable in this invention. In this system, ink supply 48 is delivered at atmospheric pressure. Piezo-electric crystal 50 produces a pressure wave along arrow "A" upon actuation by an electric signal. This pressure wave causes the ejection of a droplet of inkjet ink 46 from ink-jet nozzle 52. A data pulse train 54 produces a pattern of dots as ink-jet head 44 traverses the surface of screen 28 depositing image 56.

Thus, inkjet ink 46 is deposited in a pattern that is digitally determined to provide the information directly from a computer that will be printed by the screen by a conventional screen printing process. It is essential to the invention that inkjet ink 46 is not absorbed into the photosensitive coating, but remains as an undried image on the surface. This has various advantages which will be explained below. It is also essential that the surface of photosensitive coating 38 has suitable wetting properties so that when ink droplets 46 impact the surface, they provide smooth, even contact without excessive spreading and without reticulation.

Figure 6c shows the imaged screen being irradiated with UV radiation. In this case, inkjet ink 46 forms a barrier to the radiation. Preferably, it contains carbon black as the UV absorbing pigment, but dyes or pigments with strong absorption in the UV region may also be used. Ink 46 need have very little actual colorant that is evident to the naked

eye, just a sufficient amount to make it visible for following the imaging procedure. The UV absorption function of the dye is more important. As the ink remains wet and is not absorbed into photosensitive coating 38 but remains on the surface, the ink does not spread into coating 38 and therefore gives a sharp image with concentrated pigment or dye or other UV absorbent material. Where there is no inkjet image 56, the radiation polymerizes photosensitive coating 38 and thus reduces its solubility in the developing liquid.

As seen in Fig. 6d, the next stage of the inventive process is to wash out the unpolymerised photosensitive coating 38 together with the ink jet image. Because the inkjet image is wet, it is easily removed by any liquid that is suitable for washing out the uncured coating. Preferred liquids are weak aqueous alkali solutions such as sodium carbonate dissolved in water or mixtures of water with surfactants and other additives such as organic solvents (generally less than 20% of the developer by weight). This leaves the screen 28 with only the hardened areas of photosensitive coating 38 that create the blocked areas through which ink will not pass.

As seen in Fig. 6e, after washing, the screen may undergo a further UV hardening stage to increase resistance to any solvents that may be used in inkjet ink 46.

Generally, it is preferable to have a flat bed ink-jet imaging system so that the screen that is stretched in a frame can be directly placed under the ink-jet head. The wet imaged screen is then exposed by transferring the frame so that it resides horizontally below a UV exposure unit that irradiates the surface of the imaged screen from above.

Washing of the exposed screen can be accomplished with the solutions recommended by the screen manufacturer.

The preferred type of composition of photosensitive coating 38 has the following three components:

1. Component (A) -- between 35% and 75% by weight: UV-curable resins, i.e. oligomers and monomers that can be cross-linked, in the presence of a photoinitiator, by means of irradiation with ultra violet light.

2. Component (B) -- up to 10% of the weight of component (A): photoinitiators and synergists that will generate and promote free radicals needed for the cross-linking reaction of component (A).

3. Component (C) -- from 10% to 50% by weight: binder resins that must be soluble in water or dilute alkali, as well as in non-aqueous (organic) solvents. It has been found that due to the presence of the binder resin, the surface of the uncured film is particularly suitable for printing with aqueous ink jetinks.

In addition, there are optional ingredients, such as fillers and wetting agents, as well as dyes or pigments to aid visual examination of photosensitive coating 38. The entire mixture may be coated from a non-aqueous solvent directly onto screen 28. Preferably, it is deposited onto a release coating either on paper or film and either in a partially dry state or in a hot and sticky state screen 28 is pressed onto the coating so that after drying and cooling photosensitive coating 38 is absorbed and bonded into the surface of the screen 28 as shown in Figure 4C. Coating thickness preferably is 20 microns, but can be between 10 microns and 60 microns, in order to obtain maximal

difference in solubility between cured and uncured regions and optimise print quality and screen robustness.

The three components of photosensitive coating 38 preferably consist of materials showing suitable duality of solubility in both aqueous and non-aqueous solvents. This would exclude resins such as polyvinyl chlorides, which may be soluble in organic solvents but not in water, and polyvinyl alcohols, which are not soluble in non-aqueous solvents. The resin system used for component (C) must be soluble in organic solvents, so that the monomers and oligomers of component (A), as well as the photoinitiators of component (B), will dissolve easily and, upon application, will yield a compatible dry film. The resins must also have aqueous solubility so that the uncured coating provides suitable inkjet receptivity and can also be washed away, as described below.

Although it would be possible to make a system where the layer is washed away with an organic solvent, this is environmentally not desirable. Examples of types of resins that are useful in the system are Novalaks (functionally substituted phenol-formaldehyde resins), styrene maleic anhydride copolymers, polyvinyl methyl ether/maleic anhydride copolymer and its esters, hydroxy propyl cellulose and esterified rosin-maleic esters and maleic resins with acid values of at least 50.

The following is an example of the components used in screen blank fabrication, imaging and treatment to produce a finished screen.

EXAMPLE I

The following composition was made up (parts by weight) and milled in a ball mill for 2 hours;

Methyl Ethyl Ketone	205 parts
Kaolin	34 parts
Ebecryl 150	20 parts
Cab-O-Sil M5	8.6 parts

After milling, the following ingredients (all parts by weight) were added and stirred in, one by one.

Scripset 550	21 parts
Ebecryl 1259	110 parts
Alsynol RC 12	25 parts
Irgacure 184	2.8 parts
Irgacure 907	4.3 parts
Speedcure ITX	1.14 parts
BYK 307	1.32 parts
Sudan Black B	0.17 parts

The mixture was bar coated onto a silicone coated release paper. The mixture was air dried for 30 seconds and a commercially available woven polyester fabric suitable for graphics arts printing was pressed onto the coating. As the coating still retained solvent, the polyester fabric penetrated the surface. The sandwich was then dried at 140°C for 2 minutes to give a dry weight of coating of the above formulation of 25 grams per square meter. By this process, this coating was firmly bonded onto the surface of the polyester fabric.

The coated fabric was then tensioned in a frame and placed on an XY bed where it was imaged using the inkjet printhead described in Patent No. EP640481 assigned to Scitex. The ink used in this head was Epson ink, coded SO20010.

The imaged screen was then exposed to a UV source and then developed by washing with a solution of the following composition;

Deionised water	1050 g
Sodium carbonate	6.6g
Benzyl alcohol	12.0g
Sodium lauryl sulphate	5.4 g

The washing solution removed the ink as well as the unhardened photopolymeric coating. The screen was then further hardened by UV exposure and could then be used for conventional screen printing.

SOURCES OF TRADE NAMED RAW MATERIAL

Alsynol RC12 Rosin-maleic resin esterified with pentaerithritol. Manufactured by DSM 3150 AA Hoek van Holland.

BYK 307 Polyether modified polydimethyl siloxane. Manufactured by BYK-Gardner GmbH, Geretsried, Germany.

CAB-O-JET 200 Aqueous dispersion of carbon black. Manufactured by Cabot Corporation, Billerca, Massachusetts, US.

Cab-O-Sil M5 Fumed silica. Manufactured by Cabot Corporation, Billerca,

Massachusetts, US.

Ebecryl 150 Bisphenol A derivative of diacrylate oligomer. Manufactured by UCB Chemicals, Basle, Switzerland.

Ebecryl 1259 Aliphatic trifunctional urethane acrylate diluted with 35% hydroxy propyl methacrylate. Manufactured by UCB Chemicals, Basle, Switzerland.

Irgacure 184 1-hydroxy-cyclohexyl-phenyl-ketone. Manufactured by Ciba Geigy Corporation, CH-4002, Basle, Switzerland.

Irgacure 907 2-Methyl-1[4-(methylthio)phenyl}-2-morpholino-propan-1-one. Manufactured by Ceba-Geigy Corporation, CH-4002, Basle, Switzerland.

Scripset 550 Secondary butyl ester of styrene-maleic anhydride copolymer. Manufactured by Solutia Europe NV/S.A. Louvain-La-Neuve(Sud), Belgium.

Speedcure ITX Isopropylthioxanthone. Manufactured by Lambson, Castleford, UK.

Sudan Black B Dye. Manufactured by BDH Laboratories, Poole, Dorset, England

Q2-5211 Super-wetting agent. Manufactured by Dow Corporation, Midland, MI, USA.

Having described the invention with regard to certain specific embodiments thereof, it is to be understood that the description is not meant as a limitation, since further modifications may now suggest themselves to those skilled in the art, and it is intended to cover such modifications as fall within the scope of the appended claims.

Claims:

1. A method of producing a screen using digital imaging, said method comprising the steps of:

providing digital image information from a computer system;

providing an image-ready printing blank comprised of a screen (28) coated with a photosensitive coating (38) that permits aqueous-based inkjet ink (46) to be deposited evenly on its surface and remain in liquid condition;

printing said digital image information in UV-blocking aqueous-based inkjet ink (46) on said photosensitive coating (38) with an ink-jet printer (44), forming an image structure having exposed and unexposed areas of said photosensitive coating;

flood-curing said photosensitive coating (38) having said formed image structure with UV light such that said exposed areas of said photosensitive coating (38) are cured while said unexposed areas of said photosensitive coating (38) are blocked from UV curing by said UV-blocking ink (44); and

washing said photosensitive coating (38) so that said UV-blocking ink (44) and said unexposed image structure areas are removed,

such that the remaining cured areas of said photosensitive coating (38) form a mask on said screen (28) for use in the screen printing process.

2. The method of claim 1 further comprising the step of flood-curing said photosensitive coating with UV radiation after said washing step.

3. A method of producing a screen print using digital imaging, said method comprising the steps of:

producing a digitally imaged screen in accordance with the method of claim 1, and using said digitally imaged screen in a screen printing process.

4. The method of claim 1 wherein said ink-jet printer is a flat-bed imaging system.

5. The method of claim 1 wherein said ink-jet printer is part of a generic impulse system.

6. The method of claim 1 wherein said ink-jet printer is part of a continuous ink-jet system.

7. The method of claim 1 wherein said wash is an aqueous alkali solution.

8. The wash of claim 7 wherein said wash comprises aqueous sodium carbonate.

9. The wash of claim 7 wherein said wash comprises less than approximately 20% organic solvents.

10. A screen printing blank usable in a screen printing process, said printing blank comprising:

an image-ready printing blank comprised of a screen (28) coated with a photosensitive coating (38) that permits aqueous-based inkjet ink (46) to be deposited evenly on its surface and remain in liquid condition.

11. The printing blank of claim 10 wherein said photosensitive coating comprises wetting agents.

12. The printing blank of claim 10 wherein said photosensitive coating is between approximately 10 and 60 microns in thickness.

13. The printing blank of claim 10 wherein said photosensitive coating is approximately 20 microns in thickness.

14. The printing blank of claim 10 wherein said photosensitive coating comprises UV-curable resins, photoinitiators, synergists and binder resins.

15. The printing blank of claim 14 wherein said UV-curable resins are present as between approximately 35%-75% by weight of said photosensitive coating.

16. The printing blank of claim 14 wherein said photoinitators and synergists are present as up to approximately 10% of the weight of said UV-curable resins.

17. The printing blank of claim 14 wherein said binder resins are present as approximately 10%-50% by weight of said photosensitive coating.

18. The printing blank of claim 14 wherein said binder resins are soluble in both aqueous and non-aqueous solvents.

19. The printing blank of claim 10 wherein said photosensitive coating comprises at least one of dyes and pigments which are added to aid visual examination of said coating.

20. The printing blank of claim 14 wherein said binder resins include at least one of novalak, styrene maleic anhydride copolymers, polyvinyl methyl ether/maleic anhydride copolymer and its esters, hydroxy propyl cellulose and esterified rosin-maleic esters, and maleic resins with acid values of at least 50.

21. The printing blank of claim 10 wherein said ink remains wet during the imaging process and is not absorbed into said photosensitive coating.

22. The printing blank of claim 10 wherein said ink is comprised of carbon black.

23. The printing blank of claim 10 wherein said ink is comprised of a UV absorbing pigment or dye.

PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
1151		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/IL 00/ 00347	13/06/2000	14/06/1999
Applicant		
CREOSCITEX CORPORATION LTD.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 03 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 6b

   [ ] as suggested by the applicant.

   [X] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

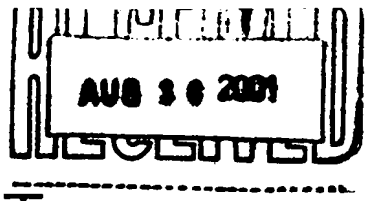
   [ ] None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The abstract is changed as follows:

Line 3: after "a screen" insert "(28)" and after "layer " insert "(38)"
Line 6: after "head " insert "(44)" and after "The ink" insert "(46)"
Line 9: after "image" insert "(56)"

PATENT COOPERATION TREATY



From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

LANGER Edward
POB 410
RAANANA 43103
ISRAEL

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	20.08.2001
Applicant's or agent's file reference ... 1151	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IL00/00347	13/06/2000	14/06/1999

Applicant
CREOSCITEX CORPORATION LTD.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Schuster-Kaechele, W Tel.+49 89 2399-2281

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
...		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IL00/00347	13/06/2000	14/06/1999
International Patent Classification (IPC) or national classification and IPC G03F7/12		
Applicant CREOSCITEX CORPORATION LTD.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of twenty-one sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10/01/2001	20.08.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Korb, W Telephone No. +49 89 2399 2284

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL00/00347

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1,2,7,8	as originally filed			
3,3a-3b,4-6, 9-18	as received on	06/08/2001	with letter of	02/08/2001

Claims, No.:

24-26	as originally filed			
1-23	as received on	06/08/2001	with letter of	02/08/2001

Drawings, sheets:

1/7-7/7	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 - 23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1 - 23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1 - 23
	No:	Claims	

2. Citations and explanations
   see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. There is no doubt in regard of the possibility of an industrial applicability of the subject-matter claimed in claims 1 - 23.

   Furthermore the subject-matter of independent claims 1 and 10 is considered to be new and to involve an inventive step with respect to the available documents cited in the International Search Report and representing a state of the art according to Rule 64(1) PCT.

   The dependent claims 2 - 9 and 11 - 23 refer to claim 1 or claim 10 directly or indirectly and meet the requirements for such claims with regard to novelty and inventive step.

2. The present application provides a method for producing a screen using digital imaging, and an image-ready screen printing blank usable in a screen printing process which is comprised of a screen coated with a photosensitive coating that permits aqueous-based inkjet ink to be deposited evenly on its surface and remain in liquid condition.

   The problems to be solved are providing optimum ink-screen surface interaction to produce a high quality inkjet mask, together with very easy removal of the mask after it has fulfilled its masking function and providing screen formulations that make this possible.

   The documents available from the ISR present integral inkjet masks in which inkjet has been used to produce masks on the screen itself so that the unimaged, unprotected parts of the coated screen can be flood cured by UV radiation. They do not, however, present workable solutions to the problem of ink receptivity and washability of the ink after curing.

   Only two of the available documents recognize the problem of post flood-curing washout and try to deal with it. PCT WO 98/51750 (Markem Corporation)

describes such a process. The inks used are "phase change" - known also as hot-melt inks. The ink is heated before application and dries by solidification as it impacts the screen. The PCT WO 98/51750 recognizes the difficulty of removing the solid ink after it had served its purpose as a mask and the inks are formulated to be auto-dispersible in water.

Furthermore GB 2 315 076 (Sericol) recognizes the same problem when phase change inks are used as integral masks for screen printing. Their solution is to use a water-soluble material having a wax-like texture.

The fact that the inks cited in the prior art are solid necessitates either the penetration of the ink film by the washing solution or the salvation or autodispersion of successive top surfaces of the ink to accomplish complete ink removal.

US 5,878,076 (McCue) attempts to circumvent the problem of mask removal after UV flood-exposure by depositing only the screen itself by, for instance, inkjet, so that the deposit is in all areas except those of the image. The deposit is then subsequently flood-cured by UV from both sides. As a layer of inkjet ink is relatively thin, multiple passes may be required to achieve the desired screen thickness.

In contrast, the present application provides an integral inkjet ink mask which remains liquid on a properly receptive photosensitive coating to provide ease of washing.

None of the available documents, neither standing alone or in combination can render the solution according to the present application obvious, that is an aqueous-based ink for deposition on a properly receptive mask to allow the ink to remain liquid and to be easily washed away with the uncured areas of the photosensitive coating.

There are other, indirect methods of producing the stencil. The light sensitive coating may be prepared as a pre-sensitized film on an intermediate base. The film can then either be transferred onto the screen before exposure and development or after exposure and development.

There is a growing need in many markets to print low run lengths and print on demand. This is because it is expensive to carry large stocks of pre-printed items and because there is an increasing demand for product customization to the need of individual customers or to relatively small groups of customers instead of mass production. The speed and cost of screen production becomes important and any means of simplifying and reducing costs is advantageous. There is also a trend to use computers to prepare artwork for printing and it would obviously be more convenient if the screen could be prepared directly from the computer information without recourse to the preparation of an intermediate photomask.

Therefore, it would be desirable to provide a method for screen printing which would not require the production of an intermediate positive film, would allow screen masters to be imaged directly from digital information in the computer so as to simplify the known work flow of the printing process, and would make it quicker and more economical. In addition, it would be desirable to produce a simple means of processing an ink jet masking image into a finished screen stencil.

SUMMARY OF THE INVENTION

Accordingly, it is a broad object of the present invention to overcome the problems of the prior art and provide a method for producing a digital screen directly from digital information in the computer in an economical fashion.

In accordance with a preferred embodiment of the present invention, there is provided a method for producing a digitally imaged screen, said method comprising the steps of:

creating a digital image on a computer system;

providing an image-ready printing blank comprised of a photosensitive layer coated on a screen;

printing said digital image in UV-blocking ink on said photosensitive layer with an ink-jet printer, forming an image structure having exposed and unexposed areas of said photosensitive layer;

flood-curing said photosensitive layer having said formed image structure with UV light such that said exposed areas of said photosensitive layer are cured while said unexposed areas of said photosensitive layer are blocked from UV curing by said UV-blocking ink; and

washing said photosensitive layer so that said UV-blocking ink and said unexposed image structure areas are removed,

such that the remaining cured areas of the photosensitive layer form a mask on said screen for use in the screen printing process.

In accordance with another aspect of the invention there is provided a screen printing blank usable in a screen printing process, said printing blank comprising:

an image-ready printing blank comprised of a photosensitive layer coated on a screen;

said printing blank having been imaged with a digital imaging system using an ink-jet printer and UV-blocking ink, forming an image structure having exposed and unexposed areas of said photosensitive layer;

said printing blank having said formed image structure having been flood-cured with UV radiation such that said exposed areas of said photosensitive layer are cured while said unexposed areas of said photosensitive layer are blocked from UV curing by said UV-blocking ink; and

said printing blank having been washed so that said UV-blocking ink and said unexposed image structure areas are removed,

such that the remaining UV cured areas of the UV curing layer form a mask on said screen for use in the screen printing process.

In a preferred embodiment, a screen is provided with a photosensitive layer, and a digitally determined image from a computer is printed on the screen by means of an inkjet printer. It is preferable to use a flat bed ink-jet imaging system so that the screen can be stretched in a frame and directly placed under the ink-jet head. The ink used need not have strong colorant, but functions as a UV mask and thus must contain a UV absorbing pigment. The ink is not absorbed into the photosensitive layer, but remains as an undried image on the surface. The ink must remain wet so that that it does not spread and

therefore gives a sharp image, and so that the UV absorbent material remains concentrated. The solvent of the ink must be chosen so as to assure that it will not affect the screen.

The screen is then irradiated with UV, and the areas which have been printed with ink serve to mask the photosensitive layer from the UV light, while those areas having no ink are exposed so that the photosensitive layer is polymerised by the UV.

After the UV irradiation stage, the screen is washed so as to remove the ink and the unpolymerised photosensitive layer. Any liquid that is suitable for washing out the unpolymerised photosensitive layer will also wash away the ink. This leaves the screen with only the polymerised areas of the photosensitive layer that create the blocked areas through which the ink will not pass.

Thus, the inventive method provides a digitally imaged screen, directly from a digital image in the computer, which can then be used in any conventional screen printing process.

Other features and advantages of the invention will become apparent from the following drawings and descriptions.

Figure 2b shows the exposure of the combination of film image 32 and stencil 20 to flood UV light. Coatings 30 are selectively hardened into a printing pattern by exposure to UV light through positive film 32 in which the image areas are opaque to the UV light. UV light penetrates film image 32 in the non-image areas and cures the corresponding areas of photosensitive coating 30 creating cured, cross-linked polymeric material 34.

Film image 32 is then physically removed and screen 28 is washed with a solvent, which may be water. As seen in Fig. 2c, the washing removes the uncured areas of photosensitive coating 30 leaving only the open woven mesh of screen 28 in these areas, while retaining cross-linked polymeric material 34. Stencil 20 may then be used for printing as described in Fig. 1.

There are other, indirect methods of producing the stencil. The light sensitive coating may be prepared as a pre-sensitized film on an intermediate base. The film can then either be transferred onto the screen before exposure and development or after exposure and development.

Prior art Figures 3a-e show cross-sectional views of an indirect method of transfer from an intermediate material to the screen after the imaging and washing stages. Figure 3a shows the donor sheet, characteristically a UV transparent substrate 36, comprised of a material such as polyester, coated with a photosensitive layer 38. A positive film serves as photomask 40 and is laid in contact with layer 38. Figure 3b depicts a UV exposure through photomask 40 onto layer 38. Where the UV is not blocked by photomask 40, layer 38 is hardened by polymerisation. The areas of layer 38 which were directly under

the UV opaque areas of photomask 40 remain unaffected. Photomask 40 is then physically removed and the surface of layer 38 is washed, usually with either an organic solvent or a weak alkali solution. This solution washes out the unpolymerised areas, leaving the polymerised areas of layer 38 as depicted in Figure 3c. Layer 38 is then pressed in contact with screen 28 as shown in Figure 3d and either by means of pressure, heat or solvent, is transferred to the screen as shown in Figure 3e, thus providing areas in which the ink is blocked, for the screen printing process.

Prior art Figures 4a-d describe an indirect transfer process where transfer from an intermediate material to the screen is done before the imaging and washing stages. Figure 4a shows support 42 coated with photosensitive layer 38 being pressed together with the screen 28, so as to transfer the photosensitive material to screen 28. As in Fig. 3, the transfer may be affected either by heat or pressure or a combination of these, or by solvent, possibly combined with heat and pressure. Support 42 is then physically peeled away and the resulting screen is shown in Fig. 4b. UV flood exposure through photomask 40 is shown in Fig. 4c. This cures the areas which are not blocked by photomask 40. After subsequent washing, as previously described, a print-ready screen results, as shown in Fig. 4d.

Fig. 5 shows a photosensitive screen stencil which has been imaged and washed according to one of the above described procedures. The image areas show the exposed screen through which ink may pass during printing.

Referring now to Figs. 6a-d, which describe the present invention. Fig. 6a shows screen 28 with a phosensitive layer 38 coated within the screen. Commercial screens

which are available and can be used in this invention have been described in the background above, in Fig. 2a (excluding photomask 26) and Fig. 4b.

Fig. 6b shows an ink jet head 44 jetting an inkjet ink 46 onto the surface of photosensitive layer 38 of screen 28. The system shown is, by way of example, a generic impulse (drop-on-demand) system, although any type of ink jet system is usable in this invention. In this system, ink supply 48 is delivered at atmospheric pressure. Piezo-electric crystal 50 produces a pressure wave along arrow "A" upon actuation by an electric signal. This pressure wave causes the ejection of a droplet of inkjet ink 46 from ink-jet nozzle 52. A data pulse train 54 produces a pattern of dots as ink-jet head 44 traverses the surface of screen 28 depositing image 56.

Thus, inkjet ink 46 is deposited in a pattern that is digitally determined to provide the information directly from a computer that will be printed by the screen by a conventional screen printing process. It is essential to the invention that inkjet ink 46 is not absorbed into the photosensitive layer, but remains as an undried image on the surface. This has various advantages which will be explained below. It is also essential that the surface of photosensitive layer 38 has good wetting properties so that when ink droplets 46 impact the surface they spread evenly without reticulation.

Figure 6c shows the imaged screen being irradiated with UV radiation. In this case, inkjet ink 46 forms a barrier to the radiation. Preferably, it contains carbon black as the UV absorbing pigment, but dyes or pigments with strong absorption in the UV region may also be used. Ink 46 need have very little actual colorant that is evident to the naked eye, just a sufficient amount to make it visible for following the imaging procedure. The UV

absorption function of the dye is more important. As the ink remains wet and is not absorbed into photosensitive layer 38 but remains on the surface, the ink does not spread into layer 38 and therefore gives a sharp image with concentrated pigment or dye or other UV absorbent material. Where there is no inkjet image 56, the radiation polymerizes photosensitive layer 38 and thus reduces its solubility in the developing liquid.

As seen in Fig. 6d, the next stage of the inventive process is to wash out the unpolymerised photosensitive layer 38 together with the ink jet image. Because the inkjet image is wet, it is easily removed by any liquid that is suitable for washing out the uncured coating. Preferred liquids are weak aqueous alkali solutions such as sodium carbonate dissolved in water or mixtures of water with surfactants and other additives such as organic solvents (generally less than 20% of the developer by weight). This leaves the screen 28 with only the hardened areas of photosensitive layer 38 that create the blocked areas through which ink will not pass.

As seen in Fig. 6e, after washing, the screen may undergo a further UV hardening stage to increase resistance to any solvents that may be used in inkjet ink 46.

The process is very simple and versatile. Screens prepared by any of the prior art methods shown in Figs. 2 to 4 can be used, as long as they have good surface wetting properties. Such screens are widely available commercially. Any available ink jet technology, including drop-on-demand or continuous ink jet can be used. However, it must be ensured that the solvent of the ink is such that it does not attack the screen. Water-based ink-jet inks are usually suitable. Phase change (wax) inks have the

disadvantage that they are not so easily removed during the screen washing out stage and may require a separate washing procedure.

Generally, it is preferable to have a flat bed ink-jet imaging system so that the screen that is stretched in a frame can be directly placed under the ink-jet head. The wet imaged screen is then exposed by transferring the frame so that it resides horizontally below a UV exposure unit that irradiates the surface of the imaged screen from above. Washing of the exposed screen can be accomplished with the solutions recommended by the screen manufacturer.

The preferred type of composition of photosensitive layer 38 has the following three components:

1. Component (A) -- between 35% and 75% by weight: UV-curable resins, i.e. oligomers and monomers that can be cross-linked, in the presence of a photoinitiator, by means of irradiation with ultra violet light.

2. Component (B) -- up to 10% of the weight of component (A): photoinitiators and synergists that will generate and promote free radicals needed for the cross-linking reaction of component (A).

3. Component (C) -- from 10% to 50% by weight: binder resins that must be soluble in water or dilute alkali, as well as in non-aqueous (organic) solvents. Due to the presence of the binder resin, the uncured film has good wetting properties – especially suitable for the surface absorption of aqueous ink jet inks.

In addition, there are optional ingredients, such as fillers and wetting agents, as well as dyes or pigments to aid visual examination of photosensitive layer 38. The entire mixture

may be coated from a non-aqueous solvent directly onto screen 28. Preferably, it is deposited onto a release coating either on paper or film and either in a partially dry state or in a hot and sticky state screen 28 is pressed onto the coating so that after drying and cooling photosensitive layer 38 is absorbed and bonded into the surface of the screen 28 as shown in Figure 4C. Coating thickness preferably is 20 microns, but can be between 10 microns and 60 microns, in order to obtain maximal difference in solubility between cured and uncured regions and optimise print quality and screen robustness.

The three components of photosensitive layer 38 preferably consist of materials showing suitable duality of solubility in both aqueous and non-aqueous solvents. This would exclude resins such as polyvinyl chlorides, which may be soluble in organic solvents but not in water, and polyvinyl alcohols, which are not soluble in non-aqueous solvents. The resin system used for component (C) must be soluble in organic solvents, so that the monomers and oligomers of component (A), as well as the photoinitiators of component (B), will dissolve easily and, upon application, will yield a compatible dry film. The resins must also have aqueous solubility so that the uncured layer provides suitable surface wetting properties and can be washed away, as described below.

Although it would be possible to make a system where the layer is washed away with an organic solvent, this is environmentally not desirable. Examples of types of resins that are useful in the system are Novalaks (functionally substituted phenol-formaldehyde resins), styrene maleic anhydride copolymers, polyvinyl methyl ether/ maleic anhydride copolymer and its esters, hydroxy propyl cellulose and esterified rosin-maleic esters and maleic resins with acid values of at least 50.

The following is an example of the components used in screen blank fabrication, imaging and treatment to produce a finished screen.

EXAMPLE I

The following composition was made up (parts by weight) and milled in a ball mill for 2 hours:

Methyl Ethyl Ketone	205 parts
Kaolin	34 parts
Ebecryl 150	20 parts
Cab-O-Sil M5	8.6 parts

After milling, the following ingredients (all parts by weight) were added and stirred in, one by one.

Scripset 550	21 parts
Ebecryl 1259	110 parts
Alsynol RC 12	25 parts
Irgacure 184	2.8 parts
Irgacure 907	4.3 parts
Speedcure ITX	1.14 parts
BYK 307	1.32 parts
Sudan Black B	0.17 parts

The mixture was bar coated onto a silicone coated release paper. The mixture was air dried for 30 seconds and a commercially available woven polyester fabric suitable for graphics arts printing was pressed onto the coating. As the coating still retained solvent, the polyester fabric penetrated the surface. The sandwich was then dried at 140°C for 2 minutes to give a dry weight of coating of the above formulation of 25 grams per square

meter. By this process, this coating was firmly bonded onto the surface of the polyester fabric.

The coated fabric was then tensioned in a frame and placed on an XY bed where it was imaged using the inkjet printhead described in Patent No. EP640481 assigned to Scitex. The ink used in this head was Epson ink, coded SO20010.

The imaged screen was then exposed to a UV source and then developed by washing with a solution of the following composition;

Deionised water	1050 g
Sodium carbonate	6.6g
Benzyl alcohol	12.0g
Sodium lauryl sulphate	5.4 g

The washing solution removed the ink as well as the unhardened photopolymeric layer. The screen was then further hardened by UV exposure and could then be used for conventional screen printing.

SOURCES OF TRADE NAMED RAW MATERIAL

Alsynol RC12 Rosin-maleic resin esterified with pentaerithritol. Manufactured by DSM 3150 AA Hoek van Holland.

BYK 307 Polyether modified polydimethyl siloxane. Manufactured by BYK-Gardner GmbH, Geretsried, Germany.

CAB-O-JET 200 Aqueous dispersion of carbon black. Manufactured by Cabot Corporation, Billerca, Massachusetts, US.

Cab-O-Sil M5 Fumed silica. Manufactured by Cabot Corporation, Billerca, Massachusetts, US.

Ebecryl 150 Bisphenol A derivative of diacrylate oligomer. Manufactured by UCB Chemicals, Basle, Switzerland.

Ebecryl 1259 Aliphatic trifunctional urethane acrylate diluted with 35% hydroxy propyl methacrylate. Manufactured by UCB Chemicals, Basle, Switzerland.

Irgacure 184 1-hydroxy-cyclohexyl-phenyl-ketone. Manufactured by Ciba Geigy Corporation, CH-4002, Basle, Switzerland.

Irgacure 907 2-Methyl-1[4-(methylthio)phenyl}-2-morpholino-propan-1-one. Manufactured by Ceba-Geigy Corporation, CH-4002, Basle, Switzerland.

Scripset 550 Secondary butyl ester of styrene-maleic anhydride copolymer. Manufactured by Solutia Europe NV/S.A. Louvain-La-Neuve(Sud), Belgium.

Speedcure ITX	Isopropylthioxanthone. Manufactured by Lambson, Castleford, UK.
Sudan Black B	Dye. Manufactured by BDH Laboratories, Poole, Dorset, England
Q2-5211	Super-wetting agent. Manufactured by Dow Corporation, Midland, MI, USA.

Having described the invention with regard to certain specific embodiments thereof, it is to be understood that the description is not meant as a limitation, since further modifications may now suggest themselves to those skilled in the art, and it is intended to cover such modifications as fall within the scope of the appended claims.

Claims:

1. A method for producing a digitally imaged screen, said method comprising the steps of:

creating a digital image on a computer system;

providing an image-ready printing blank comprised of a photosensitive layer coated on a screen;

printing said digital image in UV-blocking ink on said photosensitive layer with an ink-jet printer, forming an image structure having exposed and unexposed areas of said photosensitive layer;

flood-curing said photosensitive layer having said formed image structure with UV light such that said exposed areas of said photosensitive layer are cured while said unexposed areas of said photosensitive layer are blocked from UV curing by said UV-blocking ink; and

washing said photosensitive layer so that said UV-blocking ink and said unexposed image structure areas are removed,

such that the remaining cured areas of the photosensitive layer form a mask on said screen for use in the screen printing process.

2. The method of claim 1 further comprising the step of flood-curing said photosensitive layer with UV radiation after said washing step.

3. A method of producing a digitally imaged screen print comprising the steps of:

producing a digitally imaged screen in accordance with the method of claim 1, and

using said digitally imaged screen in a screen printing process.

4. A screen printing blank usable in a screen printing process, said printing blank comprising:

an image-ready printing blank comprised of a photosensitive layer coated on a screen;

said printing blank having been imaged with a digital imaging system using an ink-jet printer and UV-blocking ink, forming an image structure having exposed and unexposed areas of said photosensitive layer;

said printing blank having said formed image structure having been flood-cured with UV radiation such that said exposed areas of said photosensitive layer are cured while said unexposed areas of said photosensitive layer are blocked from UV curing by said UV-blocking ink; and

said printing blank having been washed so that said UV-blocking ink and said unexposed image structure areas are removed,

such that the remaining UV cured areas of the UV curing layer form a mask on said screen for use in the screen printing process.

5. The printing blank of claim 4 wherein said photosensitive layer comprises wetting agents.

6. The printing blank of claim 4 wherein said photosensitive layer is between approximately 10 and 60 microns in thickness.

7. The printing blank of claim 6 wherein said photosensitive layer is approximately 20 microns in thickness.

8. The printing blank of claim 4 wherein said photosensitive layer comprises UV-curable resins, photoinitiators, synergists and binder resins.

9. The printing blank of claim 8 wherein said UV-curable resins are present as between approximately 35%-75% by weight of said photosensitive layer.

10. The printing blank of claim 8 wherein said photoinitators and synergists are present as up to approximately 10% of the weight of said UV-curable resins.

11. The printing blank of claim 8 wherein said binder resins are present as approximately 10%-50% by weight of said photosensitive layer.

12. The printing blank of claim 8 wherein said binder resins are soluble in both aqueous and non-aqueous solvents.

13. The printing blank of claim 4 wherein said photosensitive layer comprises at least one of dyes and pigments which are added to aid visual examination of the layer.

14. The printing blank of claim 4 wherein said binder resins include at least one of novalak, styrene maleic anhydride copolymers, polyvinyl methyl ether/maleic anhydride copolymer and its esters, hydroxy propyl cellulose and esterified rosin-maleic esters, and maleic resins with acid values of at least 50.

15. The printing blank of claim 4 wherein said ink-jet printer is a flat-bed imaging system.

16. The printing blank of claim 4 wherein said ink-jet printer is part of a generic impulse system.

17. The printing blank of claim 4 wherein said ink-jet printer is part of a continuous ink-jet system.

18. The printing blank of claim 4 wherein said ink remains wet during the imaging process and is not absorbed into said photosensitive layer.

19. The printing blank of claim 4 wherein said ink is comprised of carbon black.

20. The printing blank of claim 4 wherein said ink is comprised of a UV absorbing pigment or dye.

21. The printing blank of claim 4 wherein said ink is water-based.

22. The printing blank of claim 4 wherein said wash is an aqueous alkali solution.

23. The wash of claim 22 wherein said wash comprises aqueous sodium coarbonate.

24. The wash of claim 22 wherein said wash comprises less than approximately 20% organic solvents.

25. A method for preparing a screen printing blank usable in a screen printing process, substantially as described herein by way of example and with reference to the drawings.

26. A screen printing blank usable in a screen printing process, substantially as described herein by way of example and with reference to the drawings.

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(71) Applicant *(for all designated States except US)*: **CREOSCITEX CORPORATION LTD.** [IL/IL]; Hamada St. 3, Industrial Zone, 46103 Herzliya (IL).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **FIGOV, Murray** [IL/IL]; Schwartz Street 2/18, 43213 Raanana (IL).

(74) Agent: **LANGER, Edward**; P.O. Box 410, 43103 Raanana (IL).

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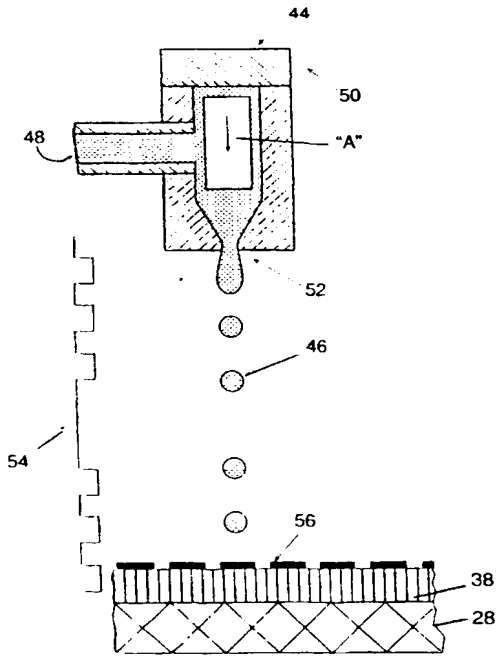
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD FOR PRODUCING A DIGITALLY IMAGED SCREEN FOR USE IN A SCREEN PRINTING PROCESS



(57) Abstract: A method for producing a digital screen printing blank usable in a screen printing process, directly from digital information in the computer, in an economical fashion. In a preferred embodiment, a screen (28) is provided with a photosensitive layer (38), and a digitally determined image from a computer is printed on the screen by means of an inkjet printer. Preferably, a flat bed ink-jet imaging system is used so that the screen can be strectched in a frame and directly placed under the ink-jet head (44). The ink (46) used need not have strong colorant, but functions as a UV mask and thus must contain a UV absorbing pigment. The ink is not absorbed into the photosensitive layer, but remains as an undried image (56) on the surface. The ink must remain wet so that it does not spread and therefore gives a sharp image, and so that the UV absorbent material remains concentrated. The solvent of the ink must be chosen so as to assure that it will not affect the screen. The screen is then irradiated with UV, and the areas which have been printed with ink serve to mask the photosensitive layer from the UV light, while those areas having no ink are exposed so that the photosensitive layer is polymerised by the UV. After the UV irradiation stage, the screen is washed so as to remove the ink and the unpolymerised photosensitive layer. Any liquid that is suitable for washing out the unpolymerised photosensitive layer will also wash away the ink. This leaves the screen with only the polymerised areas of the photosensitive layer that create the blocked areas through which the ink will not pass. Thus, the inventive method provides a digitally imaged screen, directly from a digital image in the computer, which can then be used in any conventional screen printing process.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G03F B41C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

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Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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